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A Hybrid Immersive / Non-Immersive Virtual Environment Workstation

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Introduction

The Hybrid Immersive / Non-Immersive Virtual Environment workstation combines two technologies for the presentation and exploration of virtual spaces. The Immersive and Non-Immersive components of the system are complimentary in that each approach provides a distinct perspective on the virtual environment being examined.

The Immersive component provides a user with a computer generated environment which completely surrounds the user. The computer generates images which surround the user in the virtual space and provides a first person perspective. Thus, if one is looking around in an environment along the coast then as one looks about, one can see the ocean and sea shore. This first person point of view will provide a good sense of the surroundings and the nearby features.

The Non-Immersive component of the system provides more of an overall view of the scene, much as one might gain from an aerial photograph of an area. In contrast to the Immersive experience, the Non-Immersive experience provides an overall impression of the situation and provides a context for overall strategic decision making.

We are experimenting with the components each part of the system can use and looking for effective combinations. In particular, we have been looking at using a projective image surface for the Non-Immersive user.

User Tracking

The Non-Immersive system presents the user with a stereoscopic head tracked stereo image so that the environment that is being viewed appears in front of the user. In assessing the various technologies available for implementing such a system, one which is particularly difficult is user tracking.

In general, virtual reality systems have used magnetic tracking to track the position of a user's head and hands in a virtual space in order to render the correct images. The head tracking system feeds the position and orientation of the user's head to the computer so that as the user moves about in the environment, the images sent to the display represent the scene as it would look from the user's current position.

In a ship-board environment, the magnetic systems used in traditional virtual reality systems do not seem well suited to this setting where there is a substantial amount of metal around. Indeed, one of the premier magnetic tracking companies is Polhemus, and their user manual advises:

> "**Operating Environment**: Large, metallic objects, such as desks or cabinets, located near the transmitter or receivers may adversely affect the performance of the instrument." [Pg. 6] [3Space Fastrack User's Manual Revision F OPM3609-002C Nov. 1993]

Clearly then, magnetic tracking is probably going to present some serious problems in an active maritime environment where decks and bulkheads are typically metal and space is at a premium. One alternate technology is acoustic tracking which is similar to the sonar techniques used by submarines. Logitech makes an acoustic tracker with the following characteristics:

> Tracking Area: 60" range (100 degree cone)
> Angular coverage: Line of sight
> Resolution: 0.004" Translation Error, 0.1 degrees in orientation
> Accuracy: 2% of distance from transmitter to receiver
> Reporting Rate: 50 results / second
> [Logitech 3D Mouse & Head Tracker Technical Reference Manual 620402 Rev A 11/92]

These compare well to those of the Polhemus system already mentioned which has the following characteristics:

> Positional Coverage: 30" hemispherical range (120" with reduced accuracy)
> Angular Coverage: all attitudes
> Static Accuracy: 0.03" RMS. Translational Error, 0.15 degrees in orientation
> Accuracy: 0.0002" per inch of distance from receiver to transmitter
> Update rates: 120 updates / second (1 receiver); 60 updates / second (2 receivers)
> [3Space Fastrack User's Manual Revision F OPM3609-002C Nov. 1993]

One difficulty with the Logitech tracker is that the range is 60" with a 100 degree cone.

With the Polhemus, the source is placed at the front edge of the table and the user is expected to stand near it. The 30" 'good' range of the Polhemus is illustrated in Figure 1. The user stands in front of the table and looks at the image projected in the central rectangle. As you can see, the user could walk around to the sides of the table and get out of range of the tracker. This is particularly unfortunate as the tracker does not report that the user has strayed out of the range of the tracker and it starts to report erroneous position and orientation data which are then used in the calculation of the image.

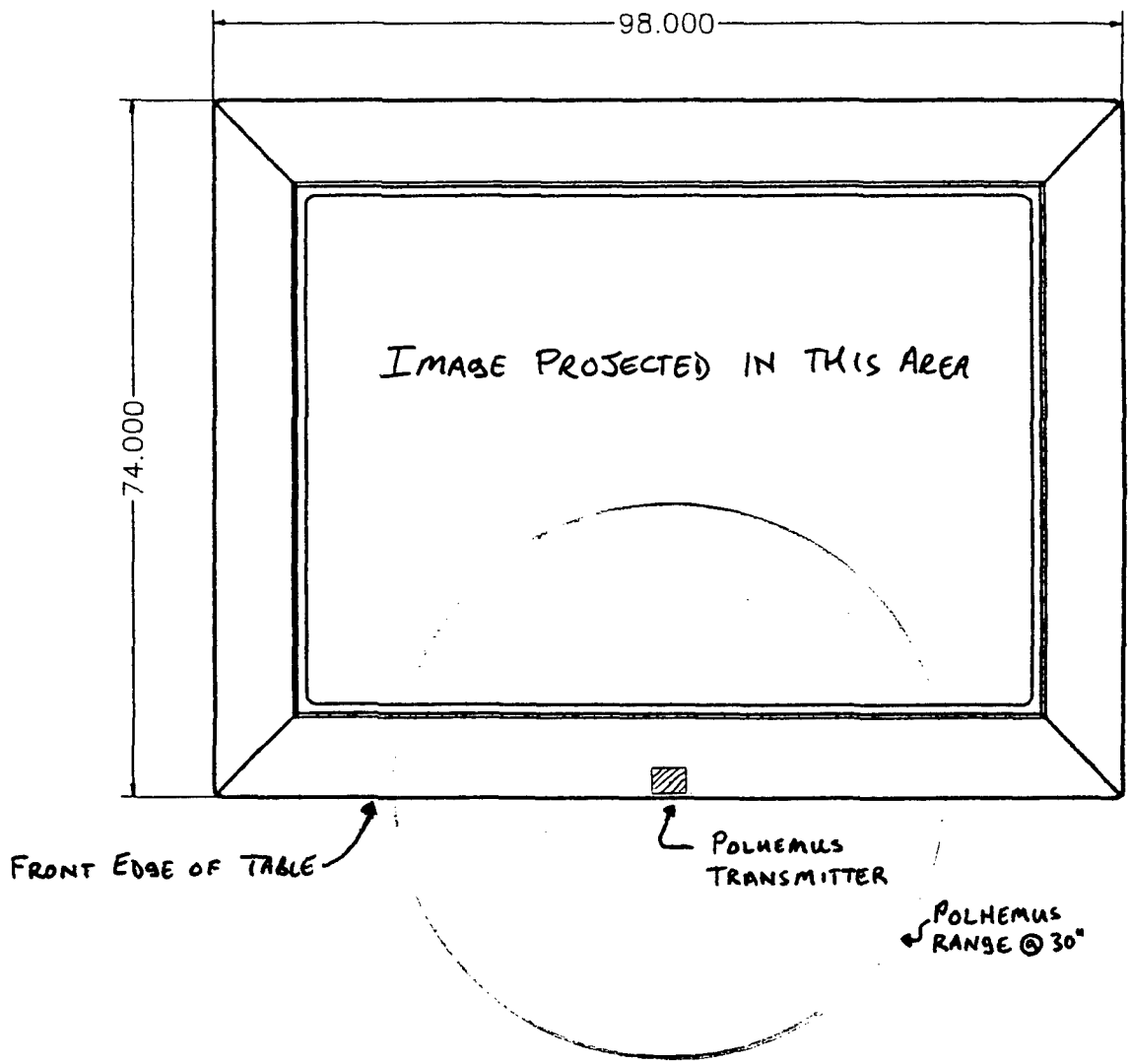

Figure 1: Position and range of a typical Polhemus tracker

When using the Logitech, the line of sight nature of the tracker implies that it should be located either at the back of the table or above. If we superimpose this on a bird's eye view of the Non-Immersive system, we can see that the range of the tracker is insufficient when placed at the back of the table surface, as shown in Figure 2.

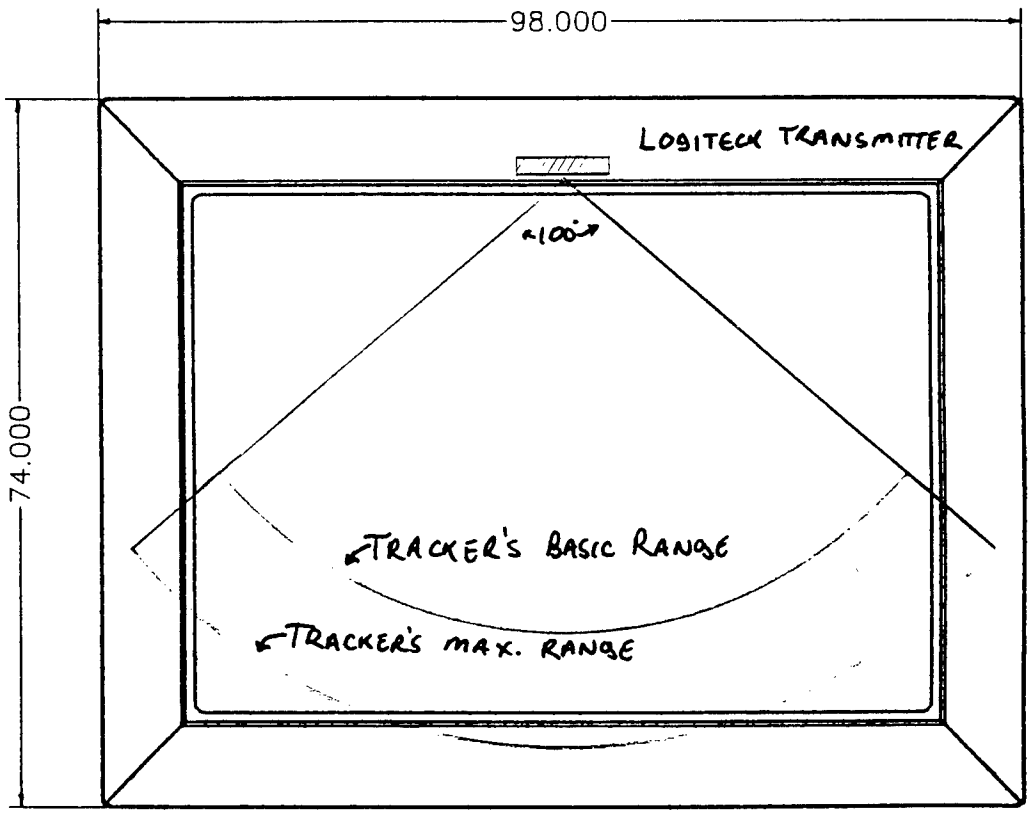

Figure 2: Position and range of a normal Logitech Tracker

In order to address this problem, we have modified the internal software of the Logitech tracker to provide a greater range which is more suited to the Non-Immersive display environment. The improved range results in a coverage roughly twice as far as the original firmware. The range is shown superimposed on the Non-Immersive display system in Figure 3.

This is clearly a better ranged tracker for the system. One disadvantage is that the back of the sides of the table are not covered by the tracker. In this case however, the tracker reports to the host computer when the user is in the fringe area (between the basic and maximum range) and also reports when the user is no longer in the tracked area. This eliminates the uncertainty as to whether the user's reported position and orientation are correct or not.

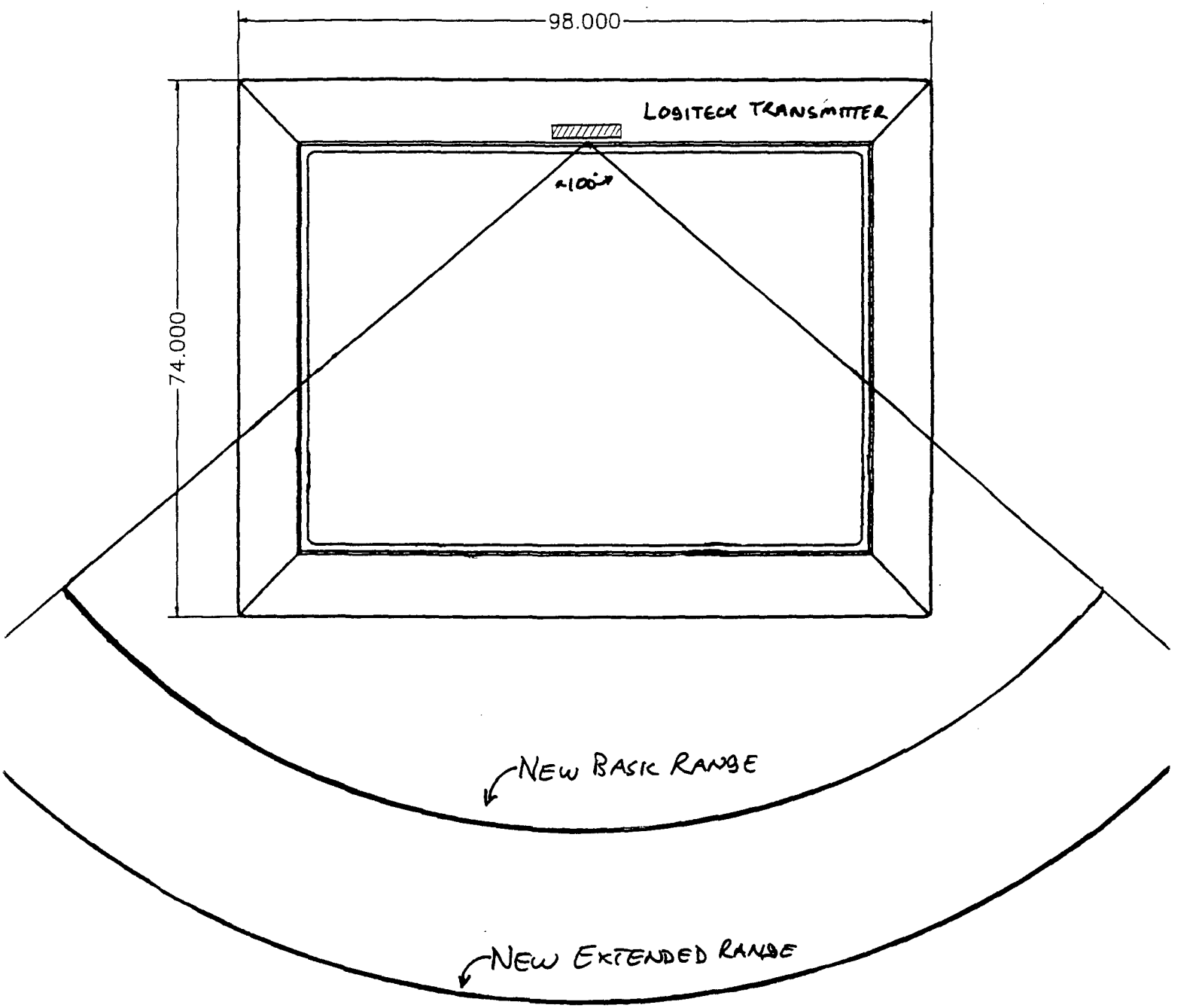

Figure 3: Position and range of a Extended range Logitech Tracker

The added advantage of using an acoustic technology is that the display system no longer has to be non metallic and the local environment is not subject to restrictions with respect to nearby metallic objects.

Conclusion

In conclusion, we have changed the internal firmware of the Logitech acoustic tracking system to achieve a suitable range for use with the Non-Immersive system. This tracking technology is not dependent on the use of non metallic materials in the area of use and is thus more compatible with a ship board environment.